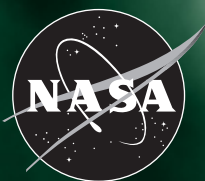


Aerospace Technology

INNOVATION

NASA's Role in Education

**Web-Based Learning Tool Licensed
Satellite Technology Helps on the Farm
Experiment Demonstrates Improved Test Method**



Aerospace Technology INNOVATION

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About the Cover:

Marshall Space Flight Center's Project LASER (Learning About Science, Engineering and Research) provides support for mentor/tutor requests, education tours, classroom presentations and curriculum development. Here, students view their reflections in an x-ray mirror at the Discovery Laboratory, an on-site MSFC laboratory facility that provides hands-on educational workshop sessions for teachers' and students' learning activities.

Online Edition: Go to <http://nctn.hq.nasa.gov> on the World Wide Web for current and past issues.

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COMMERCIAL DEVELOPMENT MISSION UPDATE

Date*	Flight	Payload	Sponsor/Coordinator
11/01	STS-108/ISS Flight "UF-1"	Advanced ASTROCULTURE™ Zeolite Crystal Growth (ZCG) Microencapsulation Electrostatic Processing System (MEPS) Commercial Biomedical Testing Module (CBTM) (Sortie)	Wisconsin Center for Space Automation and Robotics Center for Advanced Microgravity Materials Processing Center for Space Power BioServe Space Technologies

* As of August 2001.

STS—Space Transportation System
ISS—International Space Station

WELCOME TO INNOVATION

NASA Education

By Frank C. Owens

*Director, Education Division
NASA Headquarters*

SINCE THE INCEPTION OF THE NATIONAL Aeronautics and Space Administration in 1958, NASA and our nation's education program have traveled parallel paths. We share the same goal—that of exploration, discovery and the pursuit of new knowledge and achievements.

In testimony before Congress, NASA Administrator Daniel S. Goldin declared, "NASA's success depends on the educational system to produce the highly skilled and knowledgeable workforce that is necessary to perform this cutting-edge work. Likewise, the nation's educational system looks to NASA for inspiration and to exemplify doing things that once were only imaginable—feats that motivate and encourage our students to study science, mathematics, technology and engineering. Future leaders of America, even if not astronauts, scientists or engineers, must have a fundamental understanding of science, mathematics and technology to reap the rewards of NASA's discoveries."

As outlined in the NASA Implementation Plan for Education 1999–2003, NASA seeks to involve the educational community in our endeavors to inspire America's students, create learning opportunities and enlighten inquisitive minds. Our goal is to capitalize on NASA's unique assets—its mission, people and facilities—to support local, state, regional and national mathematics, science, technology and geography education reform efforts through collaboration with other organizations in high-impact reform activities.

The fundamental component of any NASA education activity is the content or knowledge derived from the NASA mission. At the Agency level, this knowledge is the outcome of the NASA mission as defined by the five Strategic Enterprises: Aerospace Technology, Human Exploration and Development of Space, Earth Science, Space Science and Biological and Physical Research. NASA's Education Program translates this content to meet our customers' needs at precollege and higher education levels.

To accomplish our goal, our national Education Program comprises initiatives that are designed to address individual state needs and to support each state's effort to improve the achievement of all students in the system. This state-based methodology allows for greater customer

focus, increased diversity and widespread and unique collaborations; and it facilitates an evaluation of our efforts at the local level. Our programs are designed to serve students and educators from kindergarten through the post-graduate level. The intention is to keep students in the pipeline as they participate in a variety of programs and, ultimately, meet the future workforce needs of NASA, the university or one of our aerospace industry partners.

NASA's national Education Program is comprised of 50 state programs. The NASA network in each state consists of NASA Field Center personnel, contractors and Principal Investigators. All states have the opportunity to be involved with their Space Grant Consortium and to have access to our NASA Aerospace Education Specialists, NASA Educator Resource Centers and NASA Field Centers.

Under contract with NASA, the Alabama Mathematics, Science and Technology Education Coalition (NASSMC) played a significant role in the development of the Alabama Mathematics, Science and Technology Initiative. The Coalition for Improving Math and Science Education in Florida is a major player in the design and oversight of a statewide professional development program funded at \$2.5 million for 2001. The Virginia Mathematics and Science Coalition participated in and strongly influenced the development and adoption of Virginia's Mathematics, Science and Technology Standards of Learning and its requirements for teacher licensure. For each of these successes, as well as many others, NASA has served as a facilitator to "align the vectors" of NASA resources to affect positive change for the state.

The future of NASA depends highly on a scientifically and technologically astute workforce and population. Ideally, a kindergarten student could begin to participate in a program such as GLOBE (Global Learning and Observations to Benefit the Environment) or local science/engineering fairs, and continue to participate beyond high school at the undergraduate, graduate and post-graduate levels.

Students and educators nationwide have the opportunity to participate in NASA missions through the Space Grant College and Fellowship Program, Undergraduate Student Research Program (USRP), Graduate Student Research Program (GSRP), Co-Op Program, Summer Faculty Fellowship Program and Resident Research Assistantships. In addition, there are numerous opportunities for students, teachers and faculty to participate in programs with NASA Field Centers and the NASA Enterprises.

To learn more about NASA's Education Programs, visit www.education.nasa.gov ✨

NASA's Role in Education

EXPLORATION, DISCOVERY AND THE PURSUIT of new knowledge and achievements are the parallel goals of NASA and the educational programs of the United States. NASA strives to reach its goals through a number of programs developed for teachers and students in all age ranges. NASA's contribution to education has been and is based on the Agency's inspiring mission, specialized workforce, close working relationship with the research and development community, and unique world-class facilities. Based on these unique attributes, NASA has created a comprehensive Education Program containing a portfolio of activities directed toward education at all levels—elementary, middle, secondary, community college, undergraduate, graduate and postdoctorate.

NASA's educational programs, projects and activities are all made up of three components: the content, which is based on the NASA mission; the customers, which are the formal and informal educational communities; and the program category, which is the manner in which NASA education activities are provided to the customer.

The fundamental component of any NASA educational activity is the content or knowledge derived from the NASA mission. At the Agency level, this knowledge is the outcome of the NASA mission as defined by the five strategic enterprises: Aerospace Technology, Human Exploration and Development of Space, Earth Science, Space Science and Biological and Physical Research. The role of NASA's Education Program is to add value by translating this content to meet customers' needs.

The customers for NASA's education products are the formal and informal educational communities. At the kindergarten through 12th-grade levels, content derived from the NASA Strategic Enterprises is tailored to meet customer needs and guided by national, state and local curriculum standards for science, mathematics, technology and geography. At the postsecondary levels, cus-

tomers are directly involved in and support NASA's mission needs. The informal education community targets both K–12 and postsecondary levels, and includes science and technology centers, museums, planetariums and other nonprofit education organizations.

Six categories make up the NASA education program and define how the content is delivered to the educational community: teacher/faculty preparation and enhancement; curriculum support and dissemination; support for systemic improvement of education; student support; educational technology; and research and development.

NASA has developed educational programs for students at all levels, in a variety of fields of interest. Following are examples of some of the many oppor-

tunities available to students through the NASA Education Program.

LEARNERS Program Aids Students

"NASA has an obligation to education," says Dr. Shelly Canright, Manager for Education Technology. The knowledge derived from NASA's research from exploring the Earth, solar system,

the space environment and aeronautics must be provided in useful and transferable media and shared with the educational community so that it might be used to meet specific needs and interests. Among the electronic media used by NASA are videoconferencing, Internet, video and CD-ROMs. NASA offers a suite of electronic products to the educational community. From the Emmy Award-winning video and Web series NASA CONNECT to the audio- and text-based Web chats and video Web casts offered through NASA Quest, NASA is committed to assuming a leadership role in supporting educational excellence and involving the educational community in its endeavors.

During the 2000–2001 school year, sixth- and seventh-grade students at the Ann Street School in Newark, New Jersey played hosts to a group of NASA scientists who had been invited to the school to learn about a student research project. The students began their presentation by explaining to the guests how certain birds, including the eagle,

THE EDUCATION PROGRAMS
NASA OFFERS ARE DESIGNED
TO INSPIRE AMERICA'S STUDENTS,
CREATE LEARNING OPPORTUNITIES AND
ENLIGHTEN INQUISITIVE MINDS.

osprey and sandhill crane, migrate along seasonal flyways during the spring. Through the use of NASA satellite data available on the Internet, the students had tracked and recorded the birds' migratory behavior.

The students are part of a growing group of student scientists who are learning the wonders of the Earth and sky, thanks to a NASA-funded effort called Leading Educators to Applications, Research and NASA-related Educational Resources (LEARNERS). Led by the Learning Technologies (LT) Project, part of NASA's Educational Technology Program, the funded LEARNERS projects are trying to enhance K-12 science, mathematics, technology and geography education in classrooms and informal learning environments across the country.

LEARNERS programs focus on using Internet-based tools to deliver content from various NASA missions. It is a unique cooperative program that links students and teachers with NASA resources and

experts. A wide variety of Web-based educational technologies delivering content related to NASA's missions will be demonstrated by seven programs that are in various stages of development at six universities and one independent research laboratory.

"As a government agency whose output adds new information to the pool of human knowledge, NASA hopes the inspiration and intellectual excitement inherent in the Aeronautics and Space Program will enrich many fields," says Mark Leon, NASA's LT Project Manager.

"Fields of study that stand to benefit from this program include social science, life science, physical science, mathematics and technology," Leon says. "So the cooperative agreements we have signed with LEARNERS participants are two-way streets. NASA also benefits through new blood and new ideas by everyone involved with LEARNERS."

Additional information on LEARNERS projects can be accessed at <http://learners.gsfc.nasa.gov>



Continuing with an experiment as a part of BioBLAST, a student discusses her progress in the lab with a science resource teacher. BioBLAST is a multimedia curriculum supplement for high school biology classes. It encourages students to conduct real scientific research, based on actual research now being conducted by NASA's Advanced Life Support Research program. Photo provided by NASA's Classroom of the Future.

Pilot Undergraduate Research Program Begins

The first group of students is participating in the new Undergraduate Student Research Program (USRP), another element in NASA's continued commitment to educational excellence and support for academic research.

USRP attracted more than 1,100 applications from undergraduate students around the country. Some 100 students representing 70 of the nation's colleges and universities—and fully representative of America's rich diversity—are participating in the program.

An essential objective of this program is to address the need to increase the nation's undergraduate and graduate science, engineering, mathematics and technology skill base. In particular, USRP will provide undergraduates with challenging research experiences designed to pique student academic interest in these fields and disciplines. The program is intended to encourage continued stu-

dent career interest aligned with NASA's research and development mission.

"We are extremely pleased with the response to this pilot program. The caliber of students who competed for these hands-on research assignments was extraordinary. And, we must commend the research communities at our NASA Centers for their very deliberate efforts to help this program achieve its goals," said Frank Owens, Director of the NASA Education Division.

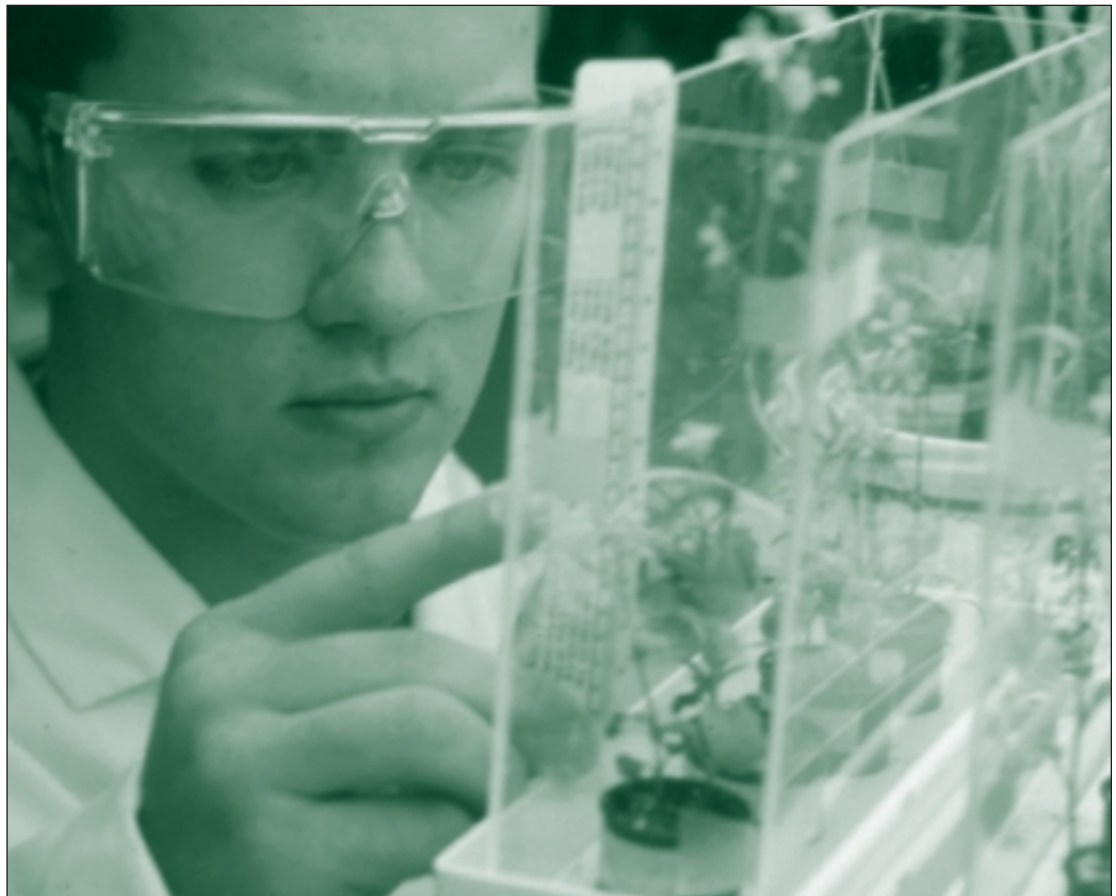
The Virginia Space Grant Consortium of Hampton, Virginia provides national coordination of the USRP pilot program.

The education programs NASA offers are designed to inspire America's students, create learning opportunities and enlighten inquisitive minds. By utilizing its unique resources, NASA is supporting educational excellence for all. ✨

For more information, contact Frank Owens, Director of the Education Division, NASA Headquarters, 300 E. Street SW, Washington, DC 20546-0001, or visit <http://education.nasa.gov> Please mention you read about it in *Innovation*.

Collecting data that will be shared with others around the world, a student measures the height of his plants that are a part of the Classroom of the Future's Farming In Space project. In this activity, students examine the growth of two varieties of wheat plants and two varieties of fast plants.

An analogous experiment will be run aboard a space shuttle and the International Space Station in 2002. Photo provided by NASA's Classroom of the Future.



TECHNOLOGY TRANSFER

JPL Licenses Technology to Map Earth

A NEW RADAR MAPPING TECHNOLOGY designed to generate high-resolution, three-dimensional maps of Earth, beneath foliage and other vegetation, has been licensed by NASA's Jet Propulsion Laboratory in Pasadena, California to EarthData International, Inc., Fresno, California.

This will be the first system that will be able to map above, through and below the vegetation canopy, providing important information such as data about landslides that are overgrown with vegetation.

The National Imagery and Mapping Agency (NIMA), in conjunction with JPL and EarthData International, Inc., showcased the Geographic Synthetic Aperture Radar (GeoSAR) mapping system to an audience of congressional sponsors and potential military and civilian users of GeoSAR map products during an open house held at the Signature Aviation Hangar, Ronald Reagan National Airport, Washington, DC in early June.

"A special feature of the GeoSAR system is its ability to acquire three-dimensional images of Earth's surface through a technique called interferometry," said Dr. Scott Hensley, the System Developer at JPL. "Because GeoSAR uses radar, the system will be able to operate both day and night, under almost any weather condition."


JPL designed and constructed the radar systems and the processing software, which was licensed to EarthData International, Inc., a mapping and remote sensing company, from the California Institute of Technology in Pasadena, which manages JPL for NASA. After the system is fully tested, EarthData plans to use this license to provide GeoSAR mapping services on a commercial basis to both military and civilian clients.

Building on JPL's years of leadership and experience in the field of interferometric radar remote sensing, the GeoSAR team concluded that the most promising way to measure Earth beneath the trees is to use a combination of X-band and P-band (UHF) radar waves. The shorter wavelength X-band radar measures near the tops of the trees, while the longer wavelength P-band radar penetrates the foliage. Using data from the dual-frequency radar, the GeoSAR system can produce high-resolution elevation models

with precise vertical accuracies of one to five meters (3 to 16 feet).

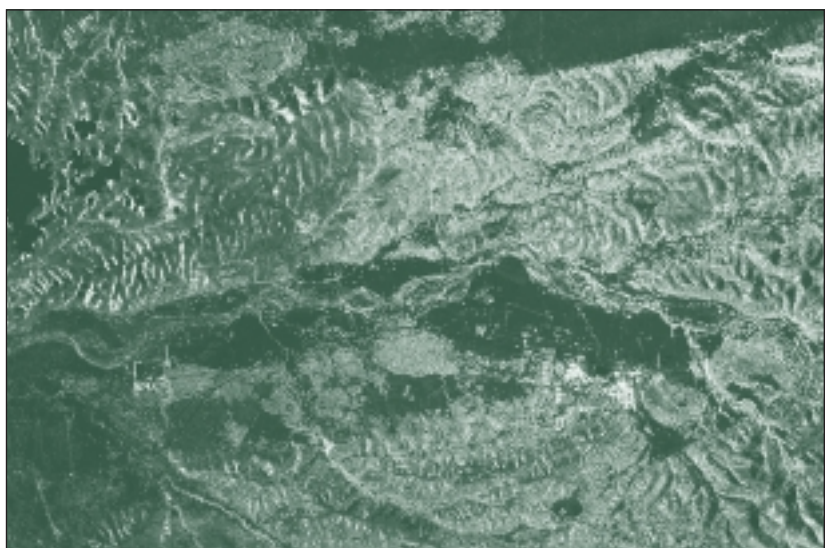
The GeoSAR system can allow the military to rapidly map vast areas where limited data exist from other sources. Other federal, state and local government agencies, as well as private sector organizations, also may use GeoSAR data to better understand seismic change in forested areas, assess forest fire damage or measure timber volumes and biomass. The data will also help in land use planning, environmental protection, flood plan management and other geographic analyses.

The program, which is managed by NIMA, will undergo a yearlong test period. During this test period, using EarthData's Gulfstream-II aircraft, JPL and EarthData, with NIMA support, will collect GeoSAR imagery and data over sites in California, the Eastern United States, the Northwest, Alaska and South America. These data collections will enable JPL to refine the data processing algorithms. NIMA anticipates the system will be commercially operational by late 2002.

The Defense and Civil Programs Office at JPL is responsible for the collaboration between JPL and EarthData. The collaboration is one of several JPL programs designed to bring the benefits of the space program to American industry. JPL is the lead U.S. center for robotic exploration of the solar system. 

For more information, please contact Scott Hensley at the Jet Propulsion Laboratory, ☎ 818/354-3322, ✉ Scott.Hensley@jpl.nasa.gov Please mention you read about it in *Innovation*.

NASA's Jet Propulsion Laboratory has licensed a new radar mapping technology designed to generate high-resolution, three-dimensional maps of Earth beneath foliage and other vegetation to EarthData International, Inc. The technology uses a combination of shorter wavelength X-band radar waves to measure near the tops of trees, while, as shown below, the longer wavelength P-band radar waves penetrate the foliage. Photo provided by Jet Propulsion Laboratory.



Students Launch Mars VE

DEVELOPED AT NASA AMES RESEARCH CENTER (ARC), Moffett Field, California, Mars Virtual Explorer (Mars VE) takes students on a journey to the future.

The Mars VE CD-ROM is an interactive multimedia project that allows students to understand basic concepts of space exploration and the search for life in the universe. Expert mentors from NASA are available for students to consult in their research efforts.

Mars VE was produced by the NASA Ames Office of Education as part of an educational outreach. Laura Shawnee, Project Manager of Mars VE, said "we wanted to break down some of the barriers to getting more students involved in math and science, and take away some of the mystery ... to make it more exciting for them."

The program was also developed to give students insight into how NASA works, according to Shawnee. "We haven't been to the planet Mars, other than Viking, so how would you explore a planet you haven't been to before? What are the things you look for to determine if there may be life

on the planet? Mars VE is trying to take some of that mystery away."

MARS VE has been licensed and is being distributed by Modern School Supplies, Inc. of Bloomfield, Connecticut. According to George Herman, Chief Executive Officer of Modern, the program has been selling for about a year. "It takes a little while to build momentum in the educational market. We are trying to bring the program to more people. We have recently signed an agreement with the leading educational software distributor in the United Kingdom for them to carry Mars VE, and the Astronomical Society of the Pacific will be carrying it in their catalog. It's a wonderful product, and I want to get it to more people."

To use the program, students work in teams and are assigned a research category. As their mission objective, they use 3D software that simulates cutting-edge technology to virtually explore four landing sites on Mars, choosing the best one to do their team's experiment.

The idea behind Mars VE, Shawnee says, is to "make students comfortable with the scientific inquiry process and to have fun doing it." ✱

For more information, contact Modern School Supplies at ☎ 800/243-2329, ext. 311, ✉ sales@modernss.com Please mention you read about it in *Innovation*.



Web-Based Learning Tool Licensed

A FLORIDA COMPANY IS COMMERCIALIZING A Web-based educational tool as the result of a Senior NASA Manager's inspiration to encourage young women to explore engineering careers. RWD Technologies, Inc., of Merritt Island, Florida, developed Launchpad to Learning, a media-rich, Web-based training environment that motivates students to discover engineering role models.

JoAnn H. Morgan, Director of the External Relations and Business Development Directorate at Kennedy Space Center (KSC), was inspired during a National Academy of Engineering summit to find a way to reach young people and promote the "under-attractive" career field of engineering. The resulting pilot project involved NASA at KSC and the RWD eLearning team. "The teamwork and commitment to the project was evident in the final product

Top: Mars VE uses 3D software that simulates cutting-edge technology, allowing students to explore four landing sites on Mars "virtually", choosing the best one to do their team's experiment. Bottom: The Mars VE CD-ROM is an interactive multimedia project that allows students to understand basic concepts of space exploration and the search for life in the universe. Photo provided by Modern School Supplies, Incorporated.

demonstrated in Washington, DC. In addition, meeting the short turnaround was a tremendous success," said Morgan.

RWD has a standing relationship with NASA, stemming from previous working relationships and existing license agreements for Web interactive training. The former Merrimac Interactive Media Corp. is also a graduate of the Florida/NASA Business Incubation Center. RWD offered NASA a solution that would engage middle school students to explore engineering through a virtual world of a space shuttle mission.

Nancy Yasecko, eLearning Solutions Manager and Principal Innovator, said that RWD has licensed its technology to Space Media Corporation, a Canadian video and multimedia resource company formed to serve the growing needs of companies involved in commercial operations in space. "The number of engineers available to NASA and to high-tech companies across the United States is getting smaller even as the demand is growing. By licensing the project to Space Media, access to over 500,000 students in its database greatly increases the project's potential impact," she pointed out.

Launchpad to Learning is described as an open portal to external learning resources. "It offers multiple Internet links to encourage students who want to know more to explore related engineering and career sites. It also includes teacher resource links that identify the state and national math and science standards covered by this site," Yasecko explained.

When a student accesses the Launchpad Web site, a montage sequence focuses the student's attention. Once an engineering discipline is selected, a female aerospace engineer talks briefly about how she became an engineer and the kind of work she does at Kennedy Space Center. She also introduces the physical laws that govern each of the three interactive areas: lift, sonic booms and shuttle reentry. The interactive areas give the student an enjoyable exposure to engineering and an early sense of technical competence.

NASA at Kennedy Space Center has a history of developing and utilizing interactive Web-based training (WBT) applications. One successful development, also licensed by Merrimac (now RWD), is the Web Interactive Training (WIT) project. Several WIT-based training courses were developed for the Safety and Mission Assurance Directorate at KSC. Courses include non-destructive evaluation, advanced statistical process control and radiography. NASA's objec-

tive was to efficiently and effectively train a large base of NASA workers using state-of-the-art technologies delivered over the Internet through a Web browser interface. ✱

For more information, contact Thomas Gould at Kennedy Space Center, ☎ 321/867-6238, ✉ Thomas.Gould-1@ksc.nasa.gov Please mention you read about it in *Innovation*.

NASA TRAFFIC SCHEDULER SEEKS COMMERCIAL PARTNERS

NASA Ames Research Center, Moffett Field, California, recently hosted a commercialization briefing at Atlanta's Hartsfield International Airport for companies interested in licensing an "airport traffic scheduler."

The automated traffic management system, originally developed by NASA to alleviate congestion at the nation's busiest airports, is now available for business application and commercial licensing.

Scientists developed the system, called TRAJECT, at Ames to improve the scheduling and directing of airplanes. Engineers tested TRAJECT at Atlanta's Hartsfield International Airport for the 1996 Olympics, and the system has been in operation there since. During a technology licensing briefing at the airport on May 30, 2001, NASA researchers discussed potential commercial applications of the system, explaining how it can benefit airports. Attendees also got a glimpse of this informational "tool" at work from the air traffic control tower in Atlanta, the busiest airport in the nation.

"Ames originally developed TRAJECT as a real-time airport surface movement advisor to electronically interconnect data from the air traffic control tower, ramp control, airline data and airline operations. This facilitates information sharing and improves taxi queuing," said Jon Hagstrom, of Ames' Computational Sciences Division. "By reducing airport departure taxi times, TRAJECT may save airlines tens of millions of dollars annually," he added.

According to its developers, the TRAJECT software tool has application in a wide range of situations, not just airports. The system can receive, process and manage real-time information from a variety of data sources. This capability allows the software to automate the scheduling of the movement of multiple items—boats, trucks, railroad cars, containers and others—in ports, shipping yards, docks and a host of similar environments.

"The TRAJECT system combines databasing, data fusing and artificial intelligence to make inferences based on numerous information streams from ground operations," explained Brian Glass, Ames' Technology Team Lead.

"This system is the only operational tool of its kind," added Systems Engineer Chris Leidich. "Just as important, it has already proven its amazing robustness and reliability at the Atlanta airport," he said.

More than 35 companies expressed an interest in attending the briefing, with representatives from 15 companies observing the demonstration of the software. To date, five companies have applied for licensing. ✱

For more information, contact Cathy Pochel, Technology Commercialization Manager, NASA Ames Research Center, Commercial Technology Office, ☎ 650/604-4595, ✉ cpochel@mail.arc.nasa.gov <http://ctoserver.arc.nasa.gov/> Please mention you read about it in *Innovation*.

ADVANCED TECHNOLOGIES

Air Pollution Monitored from Space

NASA'S TERRA SPACECRAFT HAS PRODUCED the most complete view ever assembled of the world's air pollution churning through the atmosphere, crossing continents and oceans. For the first time, policymakers and scientists now have a way to identify the major sources of air pollution and can closely track where the pollution goes anywhere on Earth.

The new global air pollution monitor onboard Terra is the innovative Measurements of Pollution in the Troposphere, or MOPITT experiment, which was contributed to the Terra mission by the Canadian Space Agency.

The instrument was developed by Canadian scientists at the University of Toronto and built by COM DEV

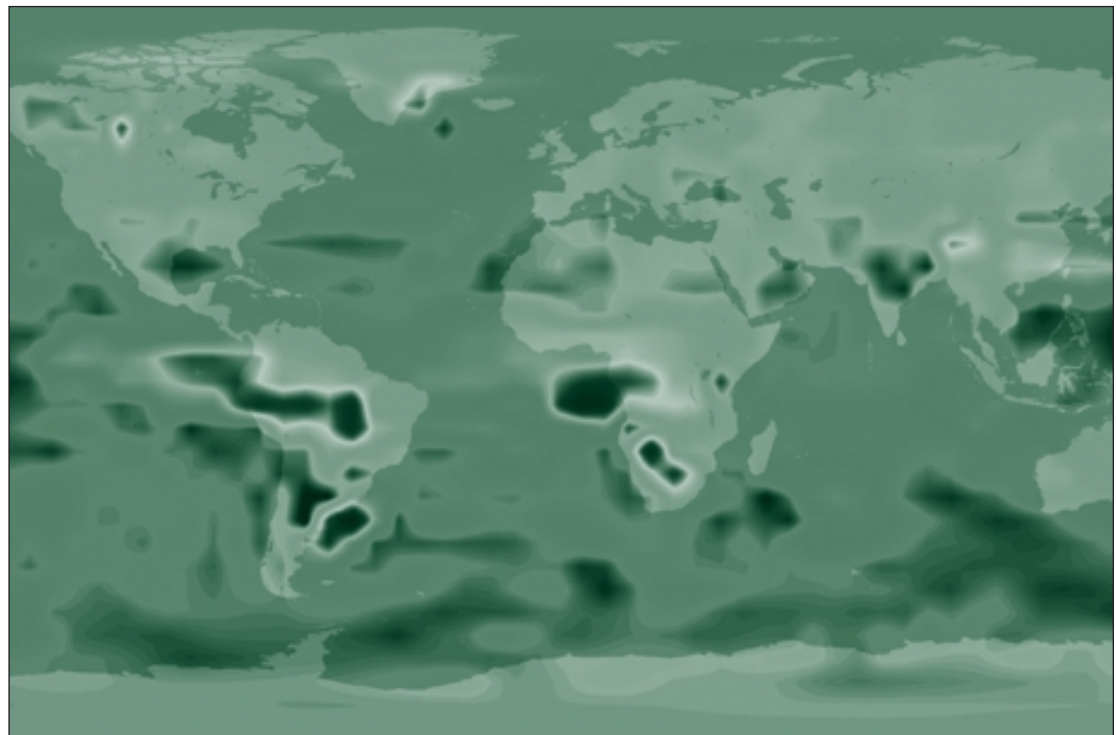
International of Cambridge, Ontario. A team at the U.S. National Center for Atmospheric Research (NCAR) processed the data. MOPITT is making the first long-term global observations of the air pollutant, carbon monoxide, as Terra circles the Earth from pole to pole, 16 times every day. Carbon monoxide is a byproduct of the incomplete burning of fossil fuels by cars, industry, home heating and the burning of natural organic matter such as wood.

"With these new observations, you clearly see that air pollution is much more than a local problem. It's a global issue," said John Gille, MOPITT Principal Investigator at NCAR in Boulder, Colorado. "Much of the air pollution that humans generate comes from natural sources such as large fires that travel great distances and affect areas far from the source."

The first MOPITT observations were released at the annual American Geophysical Union spring meeting in Boston, Massachusetts.

FOR THE FIRST TIME,
POLICYMAKERS AND SCIENTISTS
NOW HAVE A WAY TO IDENTIFY
THE MAJOR SOURCES OF AIR POLLUTION
AND CAN CLOSELY TRACK WHERE
THE POLLUTION GOES.

This flat global map shows concentrations of carbon monoxide (CO) at altitudes of 15,000 feet. Dark green colors in these images indicate the highest levels of CO (450 parts per billion). Medium green colors indicate the lowest levels of CO (50 ppb). Terra sees CO in the atmosphere from 2–3 miles above the surface, where it interacts with other gases and forms ozone. This pollutant can move upward to altitudes where it can be blown rapidly for great distances or it can move downward to the surface. CO is an air pollutant that also produces ozone, a greenhouse gas that is a human health hazard. Photo provided by Goddard Space Flight Center.



The most dramatic features, taken last year from March to December, are the immense clouds of carbon monoxide from grassland and forest fires in Africa and South America. The plumes slowly travel across the Southern Hemisphere as far as Australia during the dry season in that part of the world.

Gille was surprised to discover a strong source of carbon monoxide in Southeast Asia. The air pollution plume from this region moves over the Pacific Ocean and reaches North America, frequently at fairly high concentrations, according to Gille. While fires are the major contributor to these carbon monoxide plumes, he suspects, at times, industrial sources may also be a factor.

"The MOPITT observations represent a powerful new tool for identifying and quantifying pollution sources, and for observing the transport of pollution on international and global scales," said atmospheric chemist Daniel J. Jacob at Harvard University in Cambridge, Massachusetts, who used MOPITT data this spring in a major field campaign to study air pollution from Asia. "Such information will help us improve our understanding of the linkages between air pollution and global environmental change, and it will likely play a pivotal role in the development of international environmental policy."

MOPITT also captured the extensive air pollution generated by the forest fires in the western United States last summer. A major source of air pollution during the wintertime in the Northern Hemisphere is the burning of fossil fuels for home heating and transportation, which can be seen wafting across much of the hemisphere.

Although MOPITT cannot distinguish between individual industrial sources in the same city, it can map different sources that cover a few hundred square miles. This is accurate enough to differentiate air pollution from a major metropolitan area, for example, from a major fire in a national forest. About half of the global emissions of carbon monoxide are caused by human activities.

Carbon monoxide is not only a hazardous air pollutant, it is also a chemical compound that produces ozone, a greenhouse gas that is a human health hazard. MOPITT sees carbon monoxide in the atmosphere from two to three miles above the surface, where it interacts with other gases and forms ozone. This pollutant can move upward to altitudes where it can be blown rapidly for great distances, or it can move downward to the surface.

By tracking plumes of carbon monoxide, scientists are able to track the movements of other pollutants such as nitrogen oxides that are also produced by the same combustion processes but cannot be directly detected from space. ✱

For more information, please contact David Steitz at NASA Headquarters, ☎ 202/358-1730, ✉ dsteitz@hq.nasa.gov Please mention you read about it in *Innovation*.

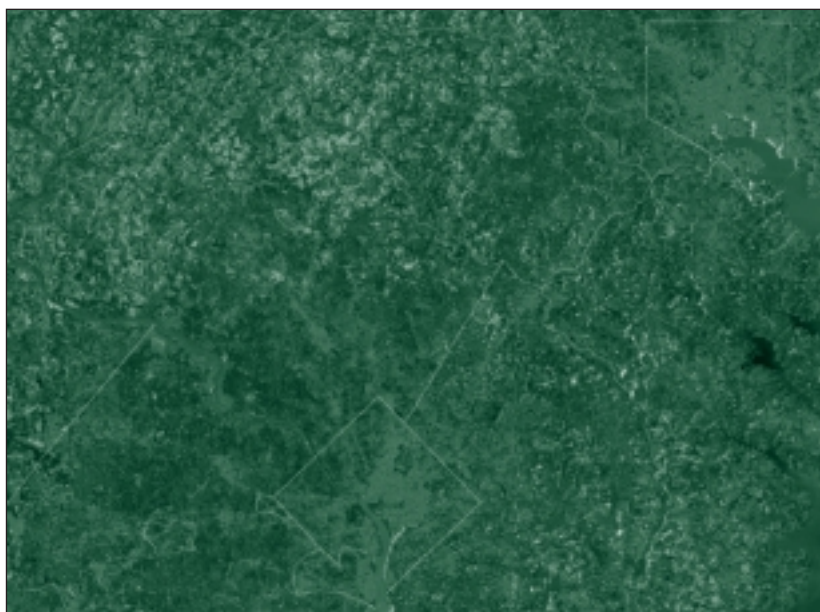
Satellite Maps Urban Sprawl

A MAJOR ADVANCE IN SATELLITE-BASED LAND surface mapping has led to the creation of more accurate and detailed maps of our cities. These maps provide urban planners with a better understanding of city growth and how rainfall runoff over paved surfaces impacts regional water quality.

Maps taken from space are invaluable to city planners and state agencies monitoring water quality in urban areas, and are replacing the more expensive and time-consuming traditional aerial photography.

These space-based maps of buildings and paved surfaces, such as roads and parking lots, which are impervious to water, can indicate where large storm water runoffs occur. Concentrated amounts of runoffs lead to erosion and elevated amounts of soil

This image shows Landsat data from March and April 1998 of the Washington/Baltimore area. A special algorithm has been applied to illuminate the changes in low-density residential land use, which exemplify sprawl. There is a link between impervious surfaces within a watershed and water quality within the watershed. Dark green represents high concentrations of impervious surfaces. Medium green represents moderate concentrations, and light green represents low concentrations of impervious surfaces. Photo provided by <http://earthobservatory.nasa.gov>



and chemical discharge into rivers, streams and ground water.

Scott Goetz, Project Manager of the NASA-sponsored Mid-Atlantic Regional Earth Science Applications Center (RESAC) at the University of Maryland, presented these highly detailed surface maps recently at the American Geophysical Union spring meeting in Boston, Massachusetts.

Andrew Smith, a Faculty Research Assistant working with Goetz at the Mid-Atlantic RESAC, developed a faster and less expensive capability, utilizing Landsat 7 and Space Imaging's Ikonos satellite data, to generate accurate maps of paved surfaces. "It's a major advance in monitoring capability because aerial photo mapping can't keep up with the pace of change," Goetz said. "Our maps of counties and cities capture new development and can be repeated much more quickly than the tedious and expensive traditional photo interpretation work."

Urban sprawl results in more paved surfaces and less area for water to drain into soils. Reduced drainage areas bring more water into fewer drainage systems at a faster rate, eroding the banks of streams and rivers, and adding more sediment to the water. "If you increase an impervious surface near a stream by creating a paved parking lot, for example, you directly affect the quality of life in the stream because of the runoff that surface will generate," Goetz said.

Smith cites previous researchers who have shown a relationship between the amounts of impervious surface cover within a watershed and the quality of surface water within that watershed. Generally, when 10 to 15 percent of an area is covered by impervious surfaces, the increased sediment and chemical pollutants in runoff have a measurable effect on water quality. When 15 to 25 percent of a watershed is paved or impervious to drainage, increased runoff leads to reduced oxygen levels and harms stream life. When more than 25 percent of surfaces are paved, many types of macroorganisms and microorganisms in streams die from concentrated runoff and sediments.

Impervious surface maps also are useful in mapping urban sprawl. Sprawl is indicated on the maps by increases in land consumption and housing construction. By monitoring an area over time, maps can show the progress of residential development. Currently, the RESAC team is working with planning departments to add the data from the maps into future urban planning models.

Smith has produced a map of the Washington-Baltimore area that quantifies how much impervious

surface there is across the entire region. Baltimore and the counties that border it have from 20 to 40 percent of impervious surface area, indicating that pollution from runoff could be a problem. The District of Columbia and surrounding watersheds in Virginia and Maryland have levels of impervious surfaces between 20 and 30 percent. Areas between and beyond the Baltimore-Washington corridor are more "green," with levels that range from 0 to 20 percent.

The RESAC team has provided maps to the Chesapeake Bay Program, Maryland's Departments of Planning and Natural Resources and Montgomery County Department of Environment, among others, to monitor water quality and changes in residential land use. These organizations incorporate the impervious surface area data into models that predict water quality, future land use and the potential effectiveness of various "smart growth" policies.

NASA launched Landsat 7 in April, 1999. Images are archived, processed and distributed by the U.S. Geological Survey, which is also responsible for day-to-day operations of the satellite. This research is being conducted as part of NASA's Earth Science Enterprise, a long-term study of how natural and human-induced change affects our global environment. ✱

For more information, visit <http://www.gsfc.nasa.gov/gsfc/earth/landsat/sprawl.htm> or contact David Steitz at NASA Headquarters, ☎ 202/358-1730, ✉ dsteitz@hq.nasa.gov Please mention you read about it in *Innovation*.

Satellite Technology Helps on the Farm

SOME OF THE PEOPLE CLOSEST TO THE LAND will be the first to benefit from a new global positioning technology developed to make NASA satellites more efficient and cost-effective.

Farmers will soon get the chance to put the new system to the test through a partnership between NASA's Jet Propulsion Laboratory in Pasadena, California and NavCom Technology Inc., a wholly owned subsidiary of Deere & Company of Moline, Illinois.

Tractors will be equipped with receivers providing instant location information, which is vital for precision farming. The technology will allow farmers to navigate fields at night and when visibility is poor.

More importantly, with soil sensors and other monitors, it will let them calculate and map out precisely where their fields may need more water, fertilizer or weed control, saving both time and money.

The system combines software developed by JPL and real-time global positioning system (GPS) data from the NASA Global GPS Network to produce corrections to the GPS orbits and clocks. These corrections are broadcast to people using communication satellites operated by NavCom, which has licensed the Internet-based Global Differential GPS software from JPL's parent institution, the California Institute of Technology in Pasadena, and plans to market the system this summer.

"NASA's Earth Science Enterprise supports pioneering exploration and discovery of our home planet, while providing America and the world with practical societal benefits from our research," said Dr. Ghassem Asrar, Associate Administrator for NASA's Office of Earth Sciences.

"Our agreement with NavCom will accelerate NASA's ability to develop, test and demonstrate the utility of global, real-time, precise GPS positioning

for scientific and public applications," said John LaBrecque, Manager of the Solid Earth and Natural Hazards Program for the Office of Earth Sciences.

While existing GPS data can be used to locate a position within a few meters, the new Global Differential GPS system provides an instantaneous position to within 10 centimeters (4 inches) horizontally and 20 centimeters (8 inches) vertically anywhere on Earth. No other system provides the same combination of accuracy and coverage.

In space, the new technology may enable improved performance by NASA's Earth-observing satellites. Since the satellites will have precise information on their position, the information may make onboard data processing more efficient

and reduce the time needed to transmit the data to the ground. NASA also expects this new positioning technology to open the possibility for new airborne exploration techniques through more accurately controlled flights of airborne sensors.

"In the area of natural hazard monitoring, real-time data from radar and ground networks of GPS receivers might provide the ability to monitor vol-

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Farmers will soon get the chance to benefit from a new global positioning satellite designed by JPL to make NASA satellites more efficient and cost-effective. The system will equip tractors with receivers to provide instant location information that is vital for precision farming. Photo provided by John Deere Corporation.

canic activity precisely and in real time, like the motion before, during and after major earthquakes,” said Dr. Yoaz Bar-Sever, Task Manager of the NASA Global Differential GPS demonstration at JPL.

The system’s ability to provide precise positioning information in real time has a variety of potential commercial applications in aviation, marine operations, land management, transportation and agriculture.

The Commercial Technology Office at JPL is responsible for the collaboration between JPL and NavCom, which will provide NASA with a continuous, GPS differential-correction signal and also will invest in improving

the NASA GPS infrastructure. This collaboration is just one of several JPL programs designed to bring the benefits of the space program to American industry.

NASA’s Earth Science Enterprise funds the development of the Global Differential GPS system. The Enterprise is a long-term research effort dedicated to understanding how human-induced and natural changes affect the global environment. ✱

For more information, contact David Steitz at NASA Headquarters, ☎ 202/358-1730, ✉ dsteitz@hq.nasa.gov Please mention you read about it in *Innovation*.

FREE NASA SOFTWARE A HIT WITH PUBLIC

A software program developed at Kennedy Space Center (KSC) to calculate pipe stress and offered free to the public has been transferred to more than 150 companies and individuals, according to the KSC Technology Commercialization Office.

Commercialization Manager Lew Parrish explained that KSC wants to share the NASA-developed Piping Stress Analysis Software with companies needing a quick, easy-to-use and efficient method of calculating pipe stress in straight pipe applications. Current methods used for piping stress analysis tend to rely on basic formulas and a hand calculator, or on complex software packages that are often difficult to use for even simple cases.

NASA KSC Engineer Eric Thaxton developed the utility that calculates the stress, the working pressure or the required pipe wall thickness in a simple, straightforward manner. The Piping Stress Analysis Software offers individuals and companies an opportunity to use a product that is more powerful and flexible than traditional paper and calculator techniques, and it is easier to use than most of the currently available software packages.

The software was originally written in Fortran 77 and ported for a DEC VAX computer running the VMS operating system. Another NASA Engineer, Lewis Lineberger, rewrote the program in C language, allowing it to run on a PC in a DOS, Windows or Windows NT environment.

Those interested in trying the software vary from private individuals to universities, the Coast Guard, engineering consulting firms, construction companies, architects, smelting companies and other NASA Centers. Most recipients of the software say they want it for internal company use, although some are evaluating it for possible marketing as a commercial product.

KSC sees potential commercial uses in the aerospace and petrochemical industries, nuclear and conventional power plants, and consulting engineering firms. Benefits of the software include its ease of use and flexibility; its compliance with industry standards, including ASME/ANSI and JIC piping codes; and its use of standard and user-definable materials.

This software calculates the stress, working pressure or the required pipe wall thickness for a given straight pipe application. It is not designed to work with curved or angled piping. The program allows the user to select a specific material from a database of commonly used materials or to create a customized database for an unlisted material.

The program analyzes pipes according to several sets of requirements, such as the ASME/ANSI B31.1 and B31.3 piping codes and the JIC hydraulics code. Both standard and SI metric versions are available.

This utility is based on the well-established theory of elasticity, the strength of materials and the work of the industry piping standard committees. It utilizes the Lamé equation, standard piping code equations and custom-derived elastic-plastic equations for high pressures. This program is easier to use and more compact than other commercially available packages of its type, thus filling a need for many users. It is also more flexible since it can calculate the stress level in a given pipe at a given pressure, the minimum pipe wall thickness or the maximum allowable pressure. ✱

For more information, contact Wendy Mizerek at Kennedy Space Center, ☎ 321/867-4879. Please mention you read about it in *Innovation*.

AEROSPACE TECHNOLOGY DEVELOPMENT

Next-Generation Space Transportation Effort Launched

NASA HAS ANNOUNCED THE FIRST ROUND OF contract awards in an agency initiative to find a more affordable and reliable highway into space. The Space Launch Initiative (SLI) is a research and development effort designed to substantially improve safety and reduce the high cost of space travel.

The studies initiated with these awards are not intended to provide a specific vehicle design. Rather, this first step marks the beginning of a process that will lead to the development of a common set of advanced technologies that NASA will make available to all U.S. aerospace companies. These cutting-edge developments will be used for future government and commercial launch systems and space transportation operations.

The SLI investment is expected to pay off with full-scale spacecraft development options around mid-decade.

"A second-generation reusable launch vehicle will open up the space frontier and significantly improve life on Earth," said Art Stephenson, Director of NASA's Marshall Space Flight Center, Huntsville, Alabama (the facility that is leading the program).

"The Space Launch Initiative is a comprehensive R&D effort that provides technology developments that dramatically increase the safety, reliability and affordability of space transportation systems," Stephenson added. "Through this new initiative, NASA's mission requirements will be met more efficiently, the U.S. launch industry can better compete in the international launch market, and our nation's leadership in space will continue to grow in the new century."

NASA first solicited proposals last fall and has awarded contracts valued at \$791 million to 22 prime contractors nationwide, including large and small companies, to allow maximum competition.

The money will be used to develop space transportation system concepts and the technologies needed to pioneer this extraordinary effort, which is expected to make the next-generation reusable launch vehicle at least 10 times safer and crew survivability 100 times greater, all at one-tenth the cost of today's space launch systems.

These leap-ahead technologies include crew survival systems, advanced tanks and airframe struc-

tures, long-life rocket engines and thermal protection systems.

"We've got a clean sheet of paper and a wide open competition," added Stephenson. "The goal is to develop technologies to enable a mid-decade decision regarding the full-scale development of a versatile space transportation system that can be used for both government and commercial services."

Nearly 300 experts throughout NASA, with technical support from the Air Force Research Laboratory, evaluated numerous proposals leading to this initial down-select and awards for this first round of SLI contracts. The awards are for a 10-month base period with options for one or more additional years.

The options enable NASA to measure performance on a yearly basis to make sure the program's ambitious goals are met. This approach also allows for continued competition in key technology areas and for NASA to take advantage of new emerging technologies.

The planned budget for the Space Launch Initiative totals \$4.8 billion through fiscal year 2006. Additional solicitations in the fall of 2001 and 2002 will commit significant additional funds to the effort.

All of NASA's Field Centers and the Air Force Research Laboratory are actively participating in the Space Launch Initiative and are vital to its success. The Marshall Space Flight Center is NASA's lead center for SLI. The Air Force Research Laboratory includes research and development facilities at nine U.S. Air Force bases. ✱

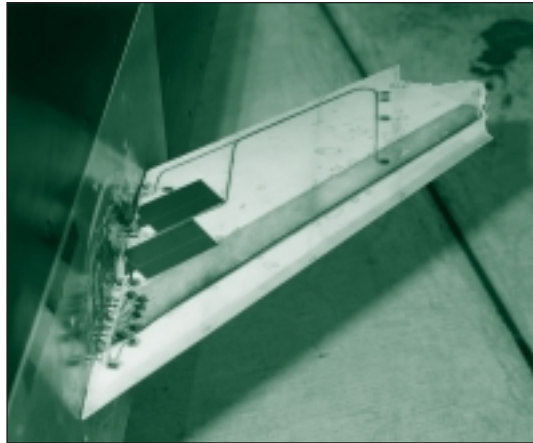
For more information, please contact Dennis E. Smith, Program Manager, Second-Generation Reusable Launch Vehicle Program Office, NASA, Mail Code: UP01, George C. Marshall Space Flight Center, Marshall Space Flight Center, AL 35812, ☎ 256/544-9119, 📠 256/544-5095. Please mention you read about it in *Innovation*.

Experiment Demonstrates Improved Test Method

A FLIGHT EXPERIMENT CALLED THE AEROSTRUCTURES Test Wing (ATW), conducted at NASA's Dryden Flight Research Center in Edwards, California, successfully demonstrated a new software data analysis tool, the flutterometer, which is designed to increase the efficiency of flight flutter testing.

AEROSPACE TECHNOLOGY DEVELOPMENT

The Aerostructures Test Wing (ATW), which consisted of an 18-inch carbon fiber test wing with surface-mounted piezoelectric strain actuators, following intentional failure on its final flight. Photo provided by NASA Dryden Flight Research Center.



The experiment consisted of an 18-inch carbon fiber test wing with surface-mounted piezoelectric strain actuators. The test wing was mounted on a special ventral flight test fixture and flown on Dryden's F-15B Research Testbed aircraft.

Five flights consisted of increasing speeds and altitudes leading to the final test point of Mach .85 at an altitude of 10,000 feet. At each Mach and altitude, stability estimations of the wing were made using accelerometer measurements in response to the piezoelectric actuator excitation. The test wing was intentionally flown to the point of structural failure, resulting in about a third of the 18-inch wing breaking off. This allowed engineers to record the effectiveness of the flutterometer over the entire regime of flutter testing, up to and including structural failure.

The actuators were moved at different magnitudes and frequency levels to induce wing vibrations and excite the dynamics during flight. Placement of the piezoelectric actuators was determined by NASA Langley Research Center, Hampton, Virginia Engineer Mercedes Reaves to maximize their effectiveness. The ATW experiment represents the first time that piezoelectric actuators were used during a flight flutter test. Flight flutter testing is the process of determining a flight envelope within which an aircraft is safe to operate. Traditional approaches for flight flutter testing do not accurately predict the onset of instability; so this testing is a very time-consuming and expensive process.

"The data acquired during the Aerostructures Test Wing experiment will help us to improve the way we model structures and to validate the flutterometer concept," said Dryden Project Engineer David Voracek. "The data that was created from these flights will be invaluable to future flight flutter test engineers for research and training."

Potential benefits of this research include reduced time and cost associated with aircraft certification by lowering the number of flights required to clear a new or modified aircraft for flight, and provision of a structural dynamics database for industry and university flutter research.

The flutterometer is an online software tool that was loaded on computers in Dryden's control room for the experiment in order to access the flight data. With this new technology, flight data can be analyzed immediately using the newly developed software to determine the stability properties of aircraft in flight. It is designed to predict the flight conditions at which the onset of flutter may occur. In this way, the flight envelope of an aircraft can be determined more quickly and safely than using traditional approaches. The ATW experiment was the first time the flutterometer was used on a flight system that actually experienced flutter.

NASA was recently awarded a patent for the flutterometer. Its software program combines the strengths of analytical predictions and online estimation methods in the development of a flutterometer concept. The flutterometer software has previously been evaluated using simulations and wind tunnels, along with flight data from several aircraft types including NASA Dryden's F-18 Systems Research Aircraft.

Flutter is the rapid and self-excited vibration of wings, tail surfaces and other aircraft parts that can damage or destroy an aircraft component. Flutter is caused by the flow of air across the surface of the structure. Effectively, the aerodynamic forces couple with the structural bending and twisting to result in the destructive vibration.

"The flutterometer represents a significant advance for flight flutter testing," said Dryden Project Engineer Rick Lind. "This tool can result in dramatic decreases in time and cost for military and commercial aircraft testing. The ATW experiment was a perfect demonstration of how the unique facilities at NASA Dryden can be used to develop tools that are beneficial to the entire aviation industry."

The ATW was designed by NASA Engineer Cliff Sticht and was manufactured by Fiberset, Inc., located in Mojave, California. ✨

For more information, contact Rick Lind at Dryden Flight Research Center, ☎ 661/276-3075, ✉ rick.lind@mail.dfrc.nasa.gov or David Voracek at Dryden Flight Research Center, ☎ 661/276-2463, ✉ david.voracek1@mail.dfrc.nasa.gov. Please mention you read about it in *Innovation*.

Science Demonstration Missions Receive Funding

THE NATIONAL AERONAUTICS AND SPACE Administration has selected two research proposals to demonstrate the capabilities of uninhabited, high-altitude aircraft as aerial platforms for Earth science and commercial applications.

The two demonstrated missions both specify use of remotely operated uninhabited aerial vehicles (UAV) which were matured under the Environmental Research Aircraft and Sensor Technology (ERAST) project at NASA's Dryden Flight Research Center, Edwards, California.

The first proposal, developed by Dr. Stanley Herwitz of Clark University, Worcester, Massachusetts, would use the Pathfinder-Plus solar-powered aircraft to aid Hawaiian coffee growers by providing the growers with color images of their crops. From this information, the growers will know, to the day, the best time for harvesting the beans, bringing the best flavor to consumers.

The second mission, proposed by Richard Blakeslee of NASA's Marshall Space Flight Center, Huntsville, Alabama, will utilize the Altus® II UAV for research missions to better understand how lightning forms and dissipates during thunderstorms.

The two demonstration proposals selected for funding were among 45 originally submitted to NASA's Office of Earth Science in response to a NASA Research Announcement. Dr. Ghassem Asrar, NASA Associate Administrator for Earth Sciences, made the final selections.

As part of NASA's UAV-based science demonstration program, these demonstration flights will show the ability of this type of aircraft to carry Earth-viewing payloads in long-duration missions at altitudes exceeding the endurance of a pilot in a traditional aircraft. These capabilities will benefit both U.S. scientific and commercial objectives, with the Pathfinder-Plus coffee-imaging study demonstrating the commercial application of UAVs, while the Altus II missions will focus on scientific research capabilities of the craft.

The Pathfinder-Plus, a slow-moving solar-electric flying wing developed by AeroVironment, Inc., of Monrovia, California, set a world altitude record for propeller-driven craft of more than 80,200 feet in 1998 during a NASA-sponsored flight near Hawaii.

The Altus II, developed by General Atomics Aeronau-

tical Systems, Inc., of San Diego, California, is a civil variant of the firm's RQ-1A Predator military reconnaissance UAV operated by the U.S. Air Force. It demonstrated the ability to fly at 55,000 feet altitude for four hours during a series of test flights over the Edwards Air Force Base test range in 1999. The Altus II has also been the airborne platform for a series of cloud radiation studies conducted by Sandia National Laboratory for the Department of Energy in Oklahoma and Hawaii in recent years.

The coffee harvest researchers will use the Pathfinder-Plus to loiter for long periods over crop fields during the harvest season. Coffee is the leading agricultural commodity traded on world markets, and Hawaiian coffee is among the finest in the world. A key to producing excellent coffee is knowing the right time to harvest the beans. The research team hopes the craft's unique capability will provide data the growers can use to select the best time to harvest the beans.

After flights over the Kauai Coffee Company plantation, the largest coffee plantation in America, the research team will brief coffee industry officials on its findings. The demonstration will allow NASA to provide sound science to a multi-billion-dollar American industry and is just one potential agricultural-management application using UAVs.

The Altus II missions will be conducted in restricted airspace over Florida, near NASA's Kennedy Space Center. When a developing storm is spotted, researchers from the University of Alabama at Huntsville, with colleagues from NASA's Goddard Space Flight Center, Greenbelt, Maryland, will send the Altus II above and around the storm, gauging the various elements that unleash the fury of storms, while the remote pilots remain safely on the ground. Using precision instruments aboard the aircraft, researchers will take measurements to determine lightning potential of the storms in the hopes of better understanding how different physical characteristics in the atmosphere can contribute to the development of lightning. These data will increase the understanding of lightning and storms, while providing federal, state and local governments with new disaster-management information for use in the areas of severe storms, floods and wild fires.

The two demonstration missions are "both scientifically exciting and commercially appealing," Dr. Asrar



NASA has selected two research proposals to demonstrate the capabilities of uninhabited, high-altitude aircraft as aerial platforms for Earth science and commercial applications. The Altus® II uninhabited aerial vehicle (UAV) will be used for research missions to better understand how lightning forms and dissipates during thunderstorms. Photo provided by NASA Dryden Flight Research Center.

said. "While validating this new breed of aircraft, we're also providing sound science with real-world, practical applications to the American people."

The two proposals selected for funding met the NASA requirement that the missions be managed in Principal Investigator mode: Each mission's Lead Investigator is responsible for choosing the UAV best suited for the experiment and for managing all aspects of the mission for NASA. NASA has identified approximately \$8 million to fund the two UAV demonstration missions over a period of four years, with funding split roughly equally between the two proposals.

The missions are part of NASA's Earth Science Enterprise, a long-term research effort aimed at understanding how human-induced and natural changes affect our global environment, while providing practical societal benefits to America today. The Earth Science Enterprise provides the sound science needed by policy and economic decision-makers to assure responsible stewardship of the global environment. ✱

For more information, contact David Steitz at NASA Headquarters, ☎ 202/358-1730, ✉ dsteitz@hq.nasa.gov Please mention you read about it in *Innovation*.

TECHNOLOGY ALLOWS ENGINEERS TO "SEE" AIRFRAME NOISE

Bright computer images of landing gear wind noise are enabling NASA engineers to pinpoint loud and preventable aircraft flight sounds more easily than in the past, raising the prospect of quieter take-offs and landings.

In a series of tests conducted at NASA's Ames Research Center, Moffett Field, California, the sounds have been depicted as colored images on a computer screen. These new test data provide critical visual information to aircraft designers concerned about possible enforcement of stricter aircraft noise rules.

"Some airports are imposing nighttime curfews on noisy take-offs and landings, encouraging aircraft manufacturers to make quieter planes," said Paul Soderman, leader of the Ames Aeroacoustics Group. "If U.S. airplane makers can't meet the new noise rules, those manufacturers may well have difficulty selling their aircraft, both domestically and in foreign markets," he speculated.

Engineers anticipate that the International Civil Aviation Organization, which makes airplane noise rules for much of the non-U.S. aviation community, also will issue lower aircraft noise limits.

"Now that we can easily see the causes of the annoying 'whooshing' wind noises that come from airliner landing gear, we can take steps to analyze and eventually reduce the noise significantly," Soderman said. Airframe parts, including landing gear, flaps and slats, create almost as much noise as the aircraft engines on approach to landing.

"We are pleased to see a lot of detail in the sound pictures. The sound images of the quarter-scale landing gear model we constructed are the first of their kind generated in the United States at this scale, to the best of our knowledge," Soderman said. Using an array of 70 microphones inside a wind tunnel wall and linked to a computer, engineers can see the vivid images of landing gear wind sounds that normally occur during aircraft take-offs and landings.

The microphone array minimizes wind tunnel airflow noise so that landing gear noise sources as small as 6 mm (about a quarter of an inch) can be identified. At full-scale, these sources are 24 mm across, or about an inch, according to engineers who conducted the tests in the Ames 7-by-10-foot wind tunnel that the U.S. Army operates for NASA.

Researchers reduced noise significantly as they removed various combinations of landing gear parts from the test model in the wind tunnel.

"A landing gear slows an airplane as it comes in for a landing, and if we reduce the drag too much, the plane would be traveling faster than it should as it approaches the runway," Soderman explained. "Removing pieces, or altering part shapes, is not as easy as it sounds because many of the changes would greatly affect how the landing gear and plane operate. The results from this test will enable researchers to decide how to create air drag, or friction, to slow the airplane without causing as much noise," he added.

"Preliminary data analysis indicates that a faired landing gear generates considerably less noise than an unmodified landing gear, and, though full fairings may not be commercially practical, the data represent a probable lower limit of landing gear noise," Soderman said. A fairing is a tear-drop-shaped shield airplane designers use to reduce air drag from wind flowing around odd-shaped surfaces.

Ames conducted the landing gear tests in collaboration with researchers at NASA's Langley Research Center, Hampton, Virginia and Boeing Commercial Airplane Co., Seattle, Washington as part of NASA's Quiet Aircraft Technology Program.

In June 2001, engineers plan to attach the quarter-scale landing gear model to a model of a quarter-scale commercial transport wing to conduct more tests. These are slated to take place in Ames' larger 40-by-80-foot wind tunnel. Researchers will measure airframe fly-over noise and surface wing pressures with and without the landing gear extended during simulated landing approaches. Researchers also will evaluate noise control devices. ✱

For more information, contact Paul T. Soderman at Ames Research Center, ☎ 650/604-6675, ✉ psoderman@mail.arc.nasa.gov Please mention you read about it in *Innovation*.

SMALL BUSINESS/SBIR

Alert System Warns of Hazards

A NEW EMERGENCY MANAGEMENT EARLY warning system, developed under the SBIR program at NASA Goddard Space Flight Center (GSFC), provides notification to users via location-intelligent pagers of life-threatening hazards and two-way communications for critical notifications such as tornadoes, floods and chemical spills.

The Earth Alert system, developed by Aeptec Microsystems, Inc., utilizes existing Global Positioning Satellites (GPS) and pager/cellular infrastructure to effectively integrate, analyze and disseminate information for emergency management. The system is designed to feed location-intelligent data to/from a centralized emergency response data center. The field users and the Emergency Operations Center can more effectively integrate, analyze and disseminate information for emergency management. It interprets incoming warnings, cautions and advisory information into geo-referenced events that require monitoring or response from the emergency community and issues, and receives notification via the pager infrastructure. Additionally, it is envisioned that Earth Alert-equipped pagers and fixed receivers located in schools, hospitals, businesses, churches and other facilities can receive the warning message.

Aeptec has designed a two-way cradle with built-in GPS and a two-way pager for use with Palm devices. Additionally, the Earth Alert application runs on the Palm devices and provides graphic display capabilities that allow the user's location to be displayed in relation to the hazard's location. The system will enable emergency managers in the field, as well as the community, to receive timely warnings specific to their area to spur life-saving action when needed. The notification and transmission of emergency information to users are determined by a

user profile that has an innovative attribute—its GPS location. This allows for targeted communications of an event to only those users within an area of pending actual disaster impact. The two-way capability of the built-in pagers also provides location-intelligent communications to an Emergency Operations Center (EOC). Police and firefighters can use the location information to coordinate rescue activities. The weather and GPS capabilities in the handheld pager devices will also have significant commercial value in commercial fishing, boating, hiking, trucking and traveling.

During the early development of the SBIR project, meetings were held with the Federal Emergency Man-

agement Agency (FEMA), the National Oceanic and Atmospheric Administration (NOAA)/National Weather Service, GSFC and other emergency agencies to determine the system requirements. GSFC has developed the enabling technology in the last 10 years, but a distribution system capable of delivering urgent disaster warning information in a timely manner to the appropriate people

within a specific community was not currently available.

Available resources and infrastructure were utilized to provide the emergency management capability. The National Weather Service has emergency information such as severe weather path forecasting and area of impact available for distribution, the Earth Alert universal pager infrastructure provides means of notification, and the GPS can provide location tracking. Aeptec's goal is to meet the requirements of FEMA and NOAA by integrating the available resources into the Earth Alert system, developing a general-purpose application that can run on a diverse suite of commercial hardware, such as the Palm or WinCE devices. The Earth Alert concept has resulted in a Memorandum of Understanding (MOU) between FEMA and GSFC to transfer technologies that will assist in the mitigation of disasters.

Aeptec has successfully designed, built and tested the handheld units that incorporate the two-way paging, GPS and graphical and text display functions.

**THE EARTH ALERT SYSTEM
UTILIZES EXISTING GLOBAL
POSITIONING SATELLITES (GPS)
AND PAGER/CELLULAR INFRASTRUCTURE
TO EFFECTIVELY INTEGRATE, ANALYZE
AND DISSEMINATE INFORMATION
FOR EMERGENCY MANAGEMENT.**

The software used by the handheld units, data center servers and EOC clients has been developed and tested. Field testing of the entire prototype system will be performed at the Aberdeen Proving Grounds this summer for a disaster mitigation study. ✱

For more information, contact Fred Schamann at Goddard Space Flight Center, ☎ 301/286-7039, ✉ schamann@gsfc.nasa.gov or Matt Herl at AEPTEC, ☎ 301/670-6770. Please mention you read about it in *Innovation*.

Small Business Develops Risk Analysis System

LUMINA DECISION SYSTEMS, A SMALL business located in Los Gatos, California, has jointly developed with NASA a system to analyze the schedule and cost risks in complex projects.

The Schedule and Cost Risk Analysis Modeling (SCRAM) system, based on a version of Lumina's

Analytica® software tool, was developed under a Phase II SBIR contract with NASA Kennedy Space Center (KSC). SCRAM was developed in response to NASA's need to identify the importance of major delays in shuttle ground processing, which is a critical function in project management and process improvement.

Lumina CEO Max Henrion explained that Analytica is marketed as a visual software tool for creating, along with analyzing and communicating quantitative models. It provides an alternative to the spreadsheet, graphical influence diagrams to show qualitative structure of models and intelligent arrays with the power to scale up simple models to handle larger problems. Analytica is available for Windows 95/98/NT 4.0 and the Macintosh operating system. The Enterprise version of Analytica 2.0 adds additional capabilities to link to virtually any database using open database connectivity (ODBC) and to hide sensitive portions of models from end-users with new privacy functionality.

Analytica was used by Resources for the Future (RFF), a nonprofit, non-advocacy research organization in Washington, DC, to facilitate a U.S. Department of Energy (DOE) assessment of the "Grand Experiment," the term used by Congress for the 1990 Clean Air Act Amendments. The amendments included market-based incentives for electrical utility companies to control their pollutant emissions of precursors to acid rain. To assess, inform and guide U.S. regulatory policies on these emissions, DOE sponsored the development of an integrated model called the Tracking and Analysis Framework (TAF). TAF required the collaborative effort of more than 30 scientists from 11 institutions across the U.S. and numerous state and federal agencies.

Enrich Consulting, Inc., a Silicon Valley-based consulting organization, specializes in customized support systems built with Analytica. Enrich provides high-end analysis, expert solutions with training and ongoing consulting to clients in banking and investments, high technology and telecommunications. Also, a leading decision support consultant, Decision Strategies, Inc., of Cumming, Georgia, used Analytica to develop models in record time, saving a major customer \$15 million.

Lumina also offers the Analytica Decision Engine (ADE) to help users employ the decision support power in the user's custom Windows 95, Windows NT and Web-based applications. When called from the user's application, ADE can read, modify and evaluate any Analytica-developed model. ADE can also be used

PHASE II AWARDS ANNOUNCED

NASA has selected 27 research proposals for negotiation of Phase II contract awards for the Small Business Innovation Research (SBIR) Program. The selected projects, which have a total value of approximately \$16 million, will be conducted by 25 small, high-technology firms located in 13 states.

The goals of this NASA program are to stimulate technological innovation, increase the use of small business (including women-owned and disadvantaged firms) in meeting federal research and development needs, and to increase private sector commercialization of results of federally funded research.

A total of 267 proposals were submitted by SBIR contractors completing Phase I projects. These proposals were evaluated to determine that they met SBIR Phase I objectives and were feasible research innovations for meeting agency needs. The new selections were combined with the 110 proposals selected last year.

Phase II continues with the development of the most promising Phase I projects. Selection criteria include technical merit and innovation, Phase I results, value to NASA, commercial potential and company capabilities. Funding for Phase II contracts may be up to \$600,000 for a two-year performance period.

The NASA SBIR Program Management Office is located at the Goddard Space Flight Center, Greenbelt, Maryland, with executive oversight by NASA's Office of Aerospace Technology, located at NASA Headquarters in Washington, DC. Individual SBIR projects are managed by NASA's ten Field Centers.

A listing of the selected companies can be found at <http://sbir.nasa.gov> ✱

For more information, contact Michael Braukus at NASA Headquarters, ☎ 202/358-1979, ✉ mbraukus@hq.nasa.gov Please mention you read about it in *Innovation*.

to create and save models, which can be reopened by ADE or by Analytica.

The deployment of SCRAM technology could save industries millions of dollars by helping them improve project management processes and identify the best process improvements to reduce bottlenecks and inefficiencies. SCRAM is based on Lumina's Analytica risk analysis software package. As a part of the SCRAM development, Lumina developed a version of Analytica that can be easily integrated into larger software systems. This capability has been commercialized and has been used in many other developments, including Web-based decision support.

Existing applications of Analytica include strategic planning, R&D management, decision analysis and risk analysis in finance, healthcare, energy, environment, aerospace and telecommunications. Analytica is being used in major corporations, consulting firms, universities and government agencies on six continents.

KSC is responsible for all aspects of space shuttle ground processing, including the testing and checkout of the three major shuttle components: the orbiter, the external tank and the solid rocket boosters. Ground processing is a large-scale, highly complex and technical endeavor that involves coordinated use of a wide range of materials and resources with NASA and contractor personnel. Processing a single shuttle mission from landing to launch is comprised of approximately 1,000 major processing tasks organized around 24 subsystems. About half of these tasks must be completed for every shuttle mission; the others include periodic maintenance and inspection, and tasks to handle special problems and mission-specific processing requirements.

The SCRAM system was designed for application to complex projects where the quantification of the impacts of specific delay categories on overall project risk adds significant value and insights to the project management team. SCRAM methodologies were successfully applied to improve the risk management processes in a large software development project. SCRAM is considered by NASA to be a significant improvement to the state-of-the-art in schedule and cost risk analysis because it allows realistic models of schedule variables (e.g., task lengths) to be built and analyzed. Existing risk analysis tools provide constrained and limited modeling capabilities. ✱

For more information, contact Thomas Gould at the Kennedy Space Center, ☎ 321/867-6238, ✉ Thomas.Gould-1@ksc.nasa.gov Please mention you read about it in *Innovation*.

SBIR Research Yields Spin-Off Company

WITH HELP FROM NASA GLENN RESEARCH Center's SBIR program, a small Cincinnati company with a technique for increasing the durability of metal components of a turbine engine has successfully brought a product to the marketplace and spun off a company to market the process.

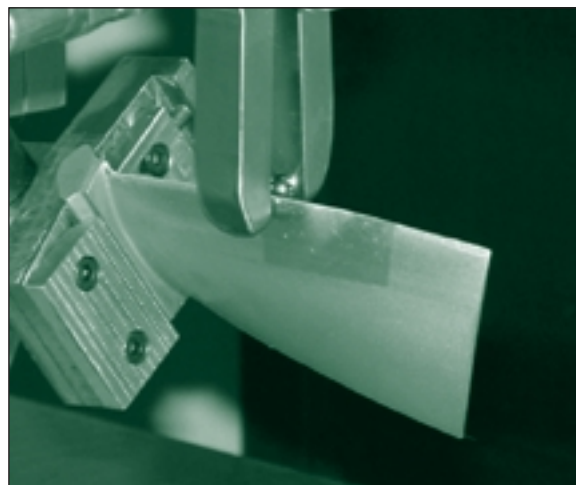
With funding support from the SBIR program, along with technical assistance from GRC researchers on the ULTRASAFE program's Crack Resistant Disk Materials element, Lambda Research, Inc. perfected their product. Their low-plasticity-burnishing apparatus produces a final surface finish which imparts a deep layer of compressive residual stress at the surface that increases the fatigue life of metallic components and their ability to withstand cracking. The affordable burnishing process produces results that are superior to those from conventional shot peening, and comparable to those of the considerably more expensive laser shock peening process.

"We fully expect it to be very useful in aircraft engine and airframe overhaul, where it can extend the life of an aging aircraft and substantially reduce the overall cost of ownership," said Paul Prevey, President of Lambda Research. In May, after three years in the program, Prevey announced that his company had begun to market its low-plasticity-burnishing process through a spin-off company, Surface Enhancement Technologies.

"This is the kind of success we like to see achieved in our program," said Walter Kim, SBIR Program Manager at Glenn. "We could tell by the continuing interest of the military and the commercial aircraft industry, as well as NASA, that they are really on to something." ✱

For more information, contact Laurel Stauber at Glenn Research Center, ☎ 216/433-2820, ✉ laurel.stauber@lerc.nasa.gov Please mention you read about it in *Innovation*.

With funding support from the SBIR program and technical assistance from GRC researchers, Lambda Research, Inc. has perfected a low-plasticity-burnishing apparatus that produces a final surface finish which imparts a deep layer of compressive residual stress at the surface, increasing fatigue life of metallic components and their ability to withstand cracking. Photo provided by NASA Glenn Research Center.





Method for Measuring Surface Shear Stress Magnitude and Direction Using Liquid Crystal Coatings

NASA Ames Research Center is seeking partners to license the Liquid Crystal Coating Method for Measuring Surface Shear Stress Patterns. This is a diagnostic technique that gives rapid visual information and measurements of surface shear stress magnitude and direction over an entire surface in a continuous, non-intrusive manner. In aerodynamics research, much valuable information can be gained from visualizing and measuring shear stress patterns on solid surfaces. Frictional forces generated by gases or liquids flowing over these surfaces can significantly influence the performance of aircraft, ships or surface-transport vehicles. Internal frictional forces, such as those caused by air compression through a jet engine or blood flow through an artificial heart chamber, also affect aerodynamic or mechanical performance. To date, measuring surface shear stress requires expensive mechanical balances or intrusive probes and sensors. This technique gives rapid visual information and measurements of surface shear stress magnitude and direction over an entire surface in a continuous, non-intrusive manner. A shear-sensitive liquid crystal coating is applied to the test surface, illuminated by a white light source, and the reflected color patterns are recorded using a color video camera.

Benefits of this technology include: non-intrusiveness, with no need to penetrate the surface or disturb the flow; ease of set-up, with optical access required only for illumination and video camera recording; inexpensiveness, with commercially available coatings costing less than \$10/square foot of surface; immediate full-surface results revealing cause-and-effect relationships between changes in model configuration or test environment and the resulting surface shear field; compatibility with force and moment balances; one millisecond response to changing conditions; and accuracy equivalent to that of existing point-measurement sensors when properly calibrated.

Potential commercial uses of the technique include wind tunnel testing of aircraft and components, such as wings and control surfaces; wind tunnel testing of automotive designs; track testing of race cars; wind tunnel testing of missiles; and water tunnel testing of racing yachts. Molecules within a shear-sensitive liquid crystal coating scatter white light as a spectrum of colors, with each color having a different orientation relative to the surface. Under normal illumination, any surface point exposed to a shear vector directed away from the observer exhibits a color change, with the color shift

being a function of shear magnitude and direction relative to that observer. Conversely, if the shear vector is directed toward the observer, the coating exhibits no color change and appears as a rust or brown color, independent of shear magnitude and direction. Based on these results, a full-surface shear stress visualization and measurement method, involving multiple oblique-view observations of the test surface, was formulated, successfully demonstrated and patented. ✨

For more information, contact Cathy Pochel, Technology Commercialization Manager, NASA Ames Research Center, ☎ 650/604-4595, 📠 650/604-1592, ✉ cpochel@mail.arc.nasa.gov Please mention you read about it in *Innovation*.

New Technology for Smaller, Low-Cost Rotary Position Sensors

NASA Marshall Space Flight Center is seeking commercial companies to consider licensing or jointly developing a new technology for smaller, low-cost rotary position sensors. The technology can be used as a conventional resolver or integrated with signal-conditioning electronics in a single unit. Potential commercial applications include any rotational measurement application, such as: printers, photocopiers, fax machines; electric motors; robotics; medical scanners; antilock brake systems; and industrial manufacturing equipment.

Benefits of the new technology include: production of conventional resolver signals; production of high-quality sensor information; offer of a full 360-degree range; availability of a small package size at a low cost; low rotary inertia; multiple output capability possible, with internal signal-conditioning electronics; continuous, absolute output without discrete jumps (like with encoders); and electrical redundancy, which can be achieved with minimal volume or cost impact. The sensor unit also can incorporate signal conditioning electronics into the housing body to develop the desired output. The sensor measures absolute position over the full 360 degrees of rotation and can be miniaturized to fit into various applications. The design can be configured in slip-ring or brushless versions, and can easily provide electrically redundant signals. The technology is immune to permanent and alternating magnetic fields, which aids in accuracy. ✨

For more information, contact Rhonda Thompson at Marshall Space Flight Center Technology Transfer Office, ☎ 256/544-4329, ✉ Rhonda.c.Thompson@msfc.nasa.gov Please mention you read about it in *Innovation*.

Technology Opportunity Showcase highlights some unique technologies that NASA has developed and that we believe have strong potential for commercial application. While the descriptions provided here are brief, they should provide enough information to communicate the potential applications of the technology. For more detailed information, contact the person listed. Please mention that you read about it in *Innovation*.



NASA Field Centers

Ames Research Center

Selected technological strengths are Information Technologies, Aerospace Systems, Autonomous Systems for Space Flight, Computational Fluid Dynamics and Aviation Operations.

Carolina Blake

Ames Research Center
Moffett Field, California 94035-1000
650/604-1754
cblake@mail.arc.nasa.gov

Dryden Flight Research Center

Selected technological strengths are Aerodynamics, Aeronautics Flight Testing, Aeropropulsion, Flight Systems, Thermal Testing and Integrated Systems Test and Validation.

Jenny Baer-Riedhart

Dryden Flight Research Center
Edwards, California 93523-0273
661/276-3689
jenny.baer-riedhart@mail.dfrc.nasa.gov

Glenn Research Center

Selected technological strengths are Aeropropulsion, Communications, Energy Technology and High-Temperature Materials Research, Microgravity Science and Technology, and Instrumentation Control Systems.

Larry Viterna

Glenn Research Center
Cleveland, Ohio 44135
216/433-3844
Larry.A.Viterna@grc.nasa.gov

Goddard Space Flight Center

Selected technological strengths are Earth and Planetary Science Missions, LIDAR, Cryogenic Systems, Tracking, Telemetry, Command, Optics and Sensors/Detectors.

George Alcorn

Goddard Space Flight Center
Greenbelt, Maryland 20771
301/286-5810
george.e.alcorn.1@gsfc.nasa.gov

Jet Propulsion Laboratory

Selected technological strengths are Deep and Near Space Mission Engineering and Operations, Microspacecraft, Space Communications, Remote and In-Situ Sensing, Microdevices, Robotics and Autonomous Systems.

Merle McKenzie

Jet Propulsion Laboratory
Pasadena, California 91109
818/354-2577
merle.mckenzie@jpl.nasa.gov

Johnson Space Center

Selected technological strengths are Life Sciences/Biomedical, Spacecraft Systems, Information Systems, Robotic and Human Space Flight Operations.

Charlene Gilbert

Johnson Space Center
Houston, Texas 77058
281/483-0474
charlene.e.gilbert@jsc.nasa.gov

Kennedy Space Center

Selected technological strengths are Emissions and Contamination Monitoring, Sensors, Corrosion Protection and Biosciences.

Jim Aliberti

Kennedy Space Center
Kennedy Space Center,
Florida 32899
321/867-6224
jim.aliberti-1@kmail.ksc.nasa.gov

Langley Research Center

Selected technological strengths are Aerodynamics, Flight Systems, Materials, Structures, Sensors, Measurements and Information Sciences.

Sam Morello

Langley Research Center
Hampton, Virginia 23681-0001
757/864-6005
s.a.morello@larc.nasa.gov

Marshall Space Flight Center

Selected technological strengths are Materials, Manufacturing, Non-Destructive Evaluation, Biotechnology, Space Propulsion, Controls and Dynamics, Structures and Microgravity Processing.

Vernotto McMillan

Marshall Space Flight Center
Huntsville, Alabama 35812
256/544-2615
vernotto.mcmillan@msfc.nasa.gov

Stennis Space Center

Selected technological strengths are Propulsion Systems, Test/Monitoring, Remote Sensing and Non-Intrusive Instrumentation.

Kirk Sharp

Stennis Space Center
Stennis Space Center, Mississippi 39529-6000
228/688-1914
kirk.sharp@ssc.nasa.gov

NASA's Business Facilitators

NASA has established several organizations whose objectives are to establish joint-sponsored research agreements and incubate small start-up companies with significant business promise.

Bill Musgrave
Ames Technology Commercialization Center
San Jose, CA
408/557-6820

Greg Hinkebein
Mississippi Enterprise for Technology
Stennis Space Center, MS
228/688-3144

Wayne P. Zeman
Lewis Incubator for Technology
Cleveland, OH
440/260-3300

David Kershaw
Florida/NASA Business Incubation Center
Titusville, FL
321/267-5601

Bridget Smalley
University of Houston/NASA Technology Center
Houston, TX
713/743-9155

Joanne Randolph
Business Technology Development Center
Huntsville, AL
256/704-6000, ext. 202

Richard C. (Michael) Lewin
Department of Business and Economic Development
Greenbelt, MD
800/541-8549

Julie A. Holland
NASA Commercialization Center/California State Polytechnic University
Pomona, CA
909/869-4477

Martin Kaszubowski
Hampton Roads Technology Incubator
Hampton, VA
757/865-2140

Ann Lansinger
Merger Technology Center NASA Business Incubator
Baltimore, MD
410/327-9150

Small Business Programs

Carl Ray
NASA Headquarters
Small Business Innovation Research Program (SBIR/STTR)
202/358-4652
cray@hq.nasa.gov

Paul Mexcur
Goddard Space Flight Center
Small Business Technology Transfer (SBIR/STTR)
301/286-8888
paul.mexcur@pop700.gsfc.nasa.gov

NASA-Sponsored Commercial Technology Organizations

These organizations were established to provide rapid access to NASA and other federal R&D agencies and to foster collaboration between public and private sector organizations. They also can direct you to the appropriate point of contact within the Federal Laboratory Consortium. To reach the RTTC nearest you, call 800/642-2872.

Ken Dozier
Far West Technology Transfer Center
University of Southern California
Los Angeles, CA 90007
213/743-2353

William Gasko
Center for Technology Commercialization
Westborough, MA 01581
508/870-0042

David Bridges
Economic Development Institute
Georgia Institute of Technology
Atlanta, GA 30332
404/894-6786

Gary F. Sera
Mid-Continent Technology Transfer Center
Texas A&M University
College Station, TX 77840
979/845-8762

Charlie Blankenship
Technology Commercialization Center, Inc.
Newport News, VA 23606
757/269-0025

Pierrette Woodford
Great Lakes Industrial Technology Center
Battelle Memorial Institute
Cleveland, OH 44070
440/734-0094

Joseph P. Allen
National Technology Transfer Center
Wheeling Jesuit University
Wheeling, WV 26003
800/678-6882

Dan Winfield
Research Triangle Institute Technology Applications Team
Research Triangle Park, NC 27709
919/541-6431

NASA ONLINE

Go to the **NASA Commercial Technology Network (NCTN)** on the World Wide Web at <http://nctn.hq.nasa.gov> to search NASA technology resources, find commercialization opportunities and learn about NASA's national network of programs, organizations and services dedicated to technology transfer and commercialization.

